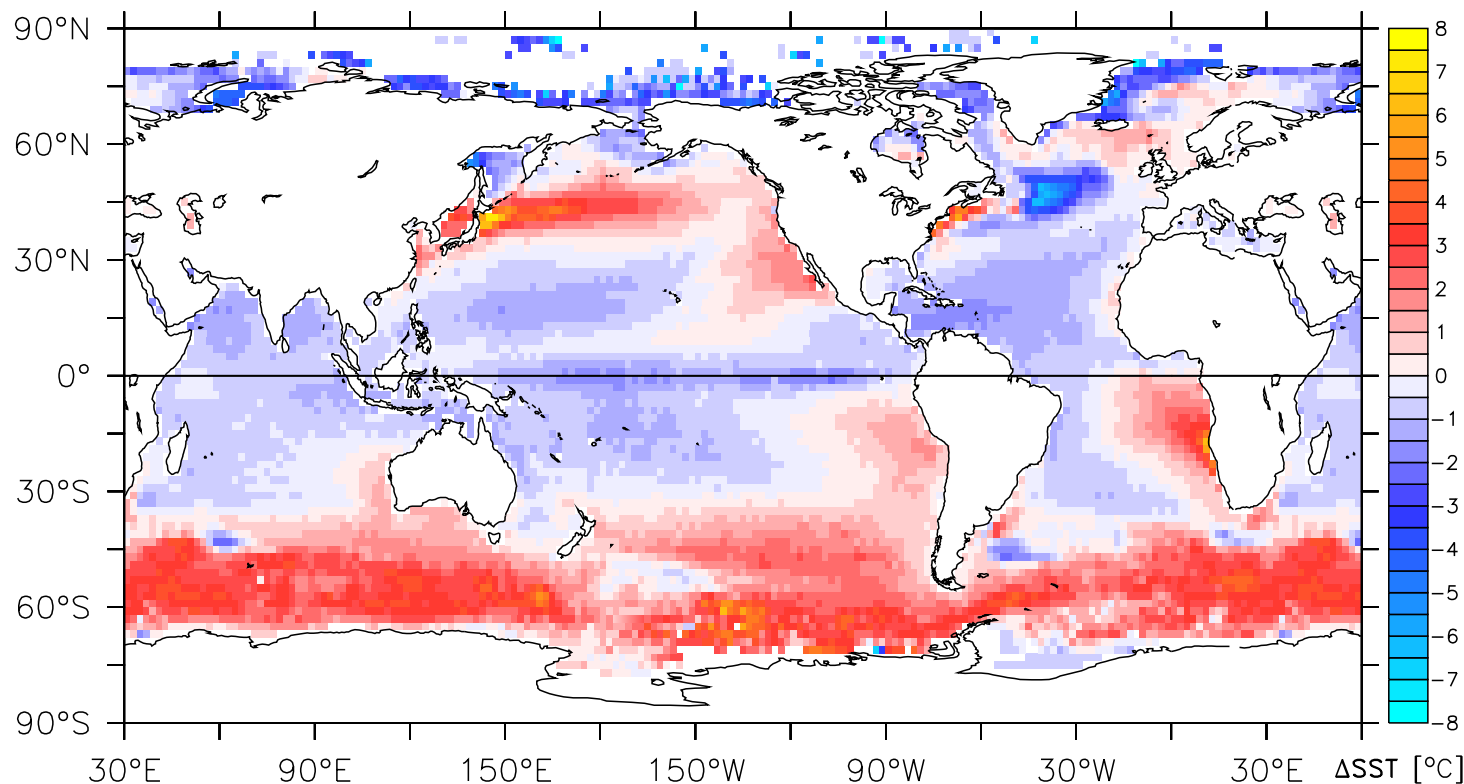


# A posteriori adjustment of near-term climate predictions: Accounting for the drift dependence on the observed IC

Neven S. Fučkar<sup>1</sup>, Danila Volpi<sup>1</sup>, Virginie Guemas<sup>1,2</sup>, and Francisco J. Doblas-Reyes<sup>1,3</sup>

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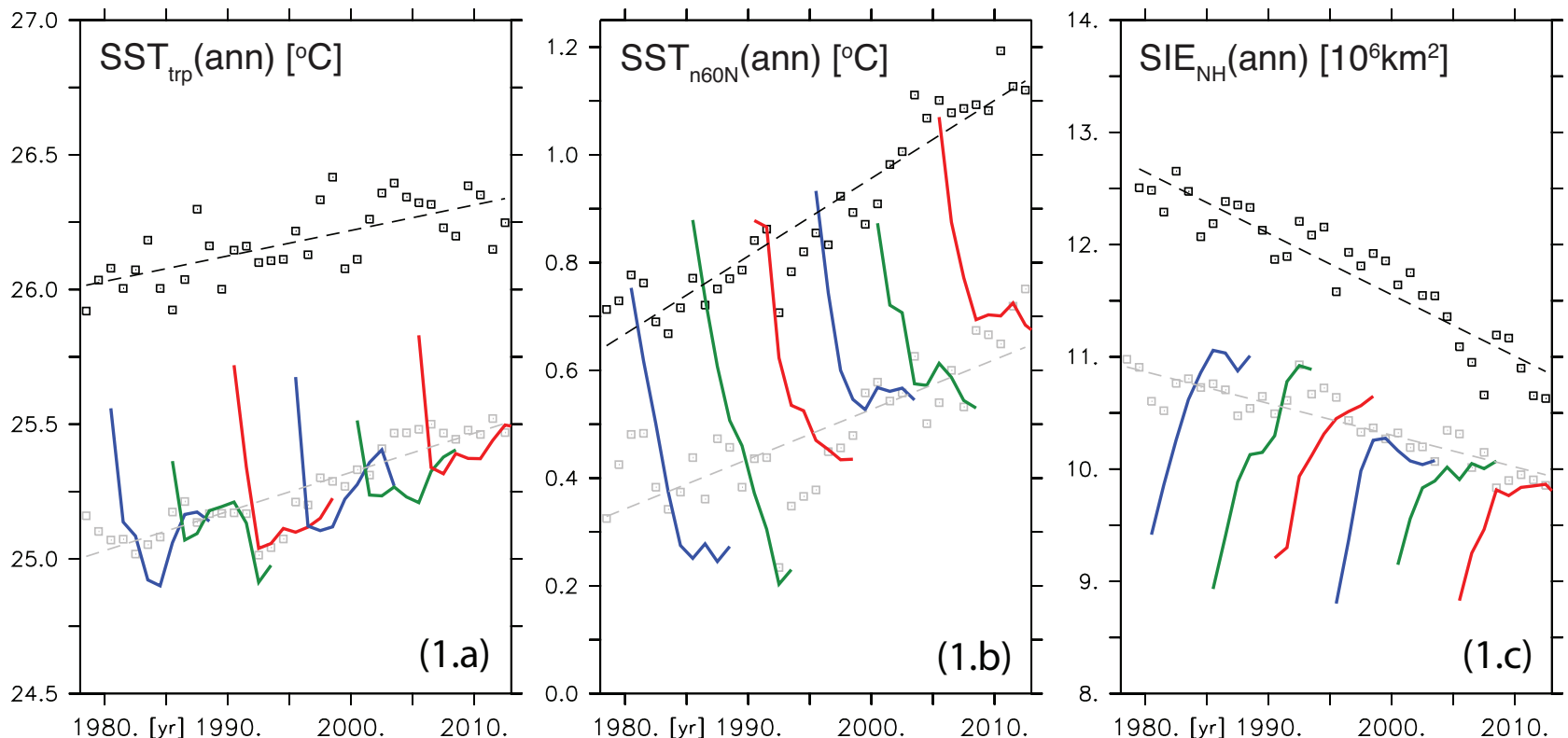
SST (EC-Earth v2.3 historical simulation – ICOADS 2.5) from 1979 to 2012



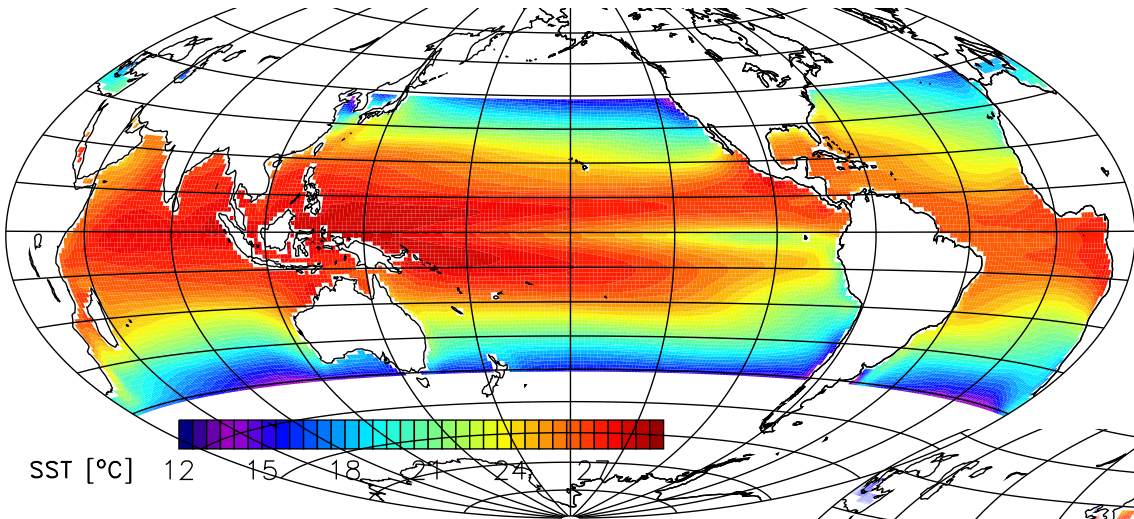
Every climate model is an approximation of the climate system, “endowed” with inherent sources of errors: *i)* discretization errors, *ii)* context errors (includes **IC errors**), *iii)* scale representation errors and *iv)* process representation errors

⇒ **All models develop biases, i.e., systematic differences from observed climate**

- Observational analyses: ERSSTv3b and NSIDC sea ice concentration
- Climate forecast system: EC-Earth2.3 (historical simulations and decadal predictions)

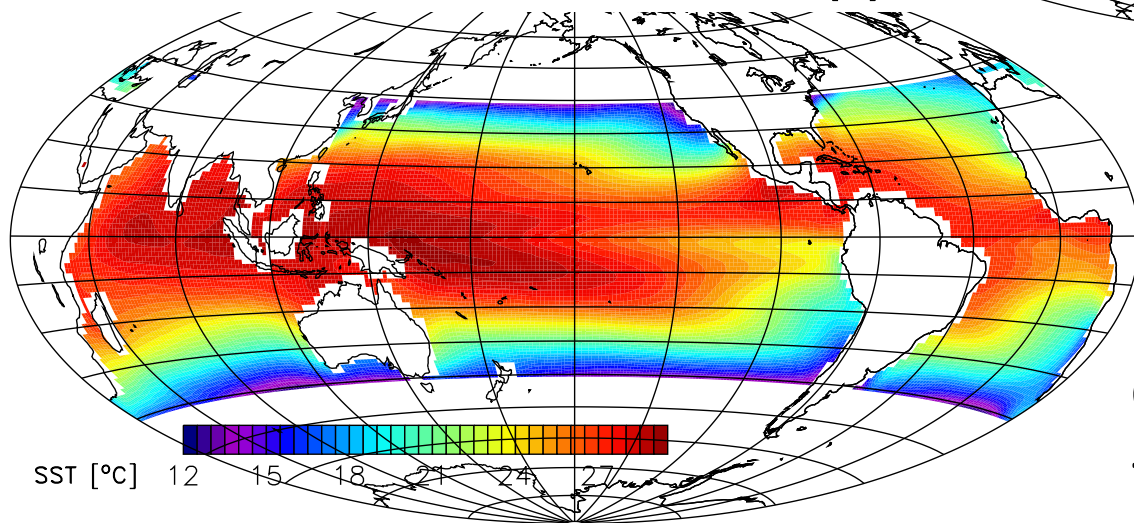
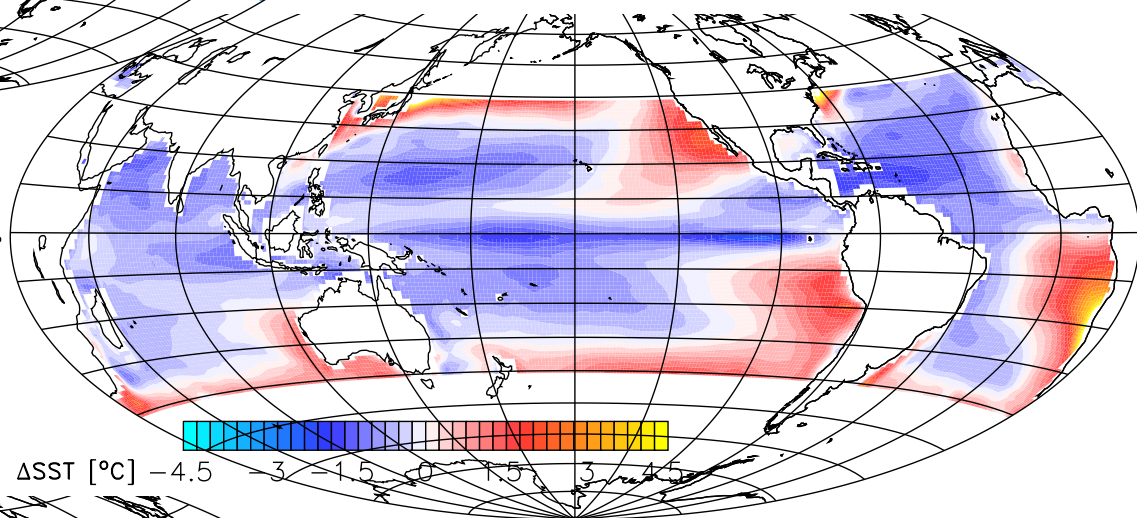


**Annual means over the modern observational era (since 1979)**

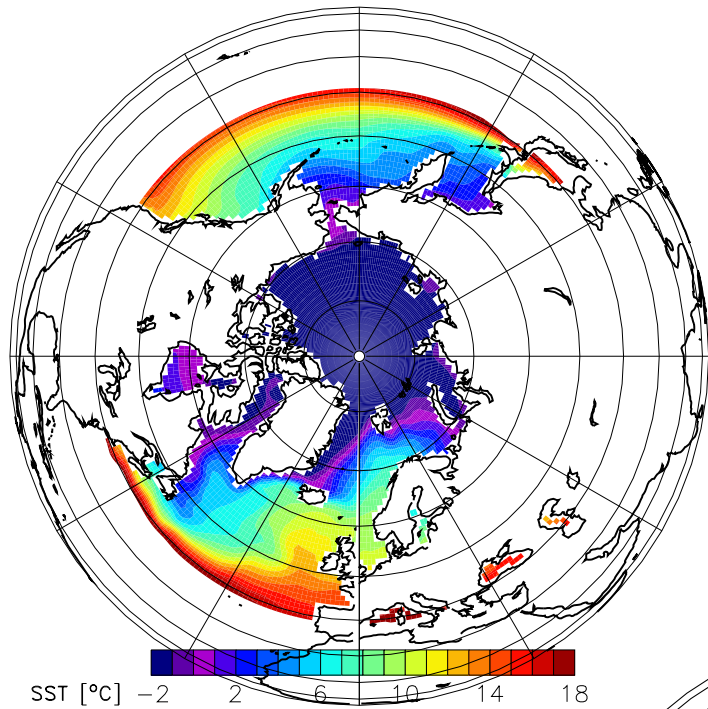


Hist. sim. EC-Earth2.3  
<1979-2012>

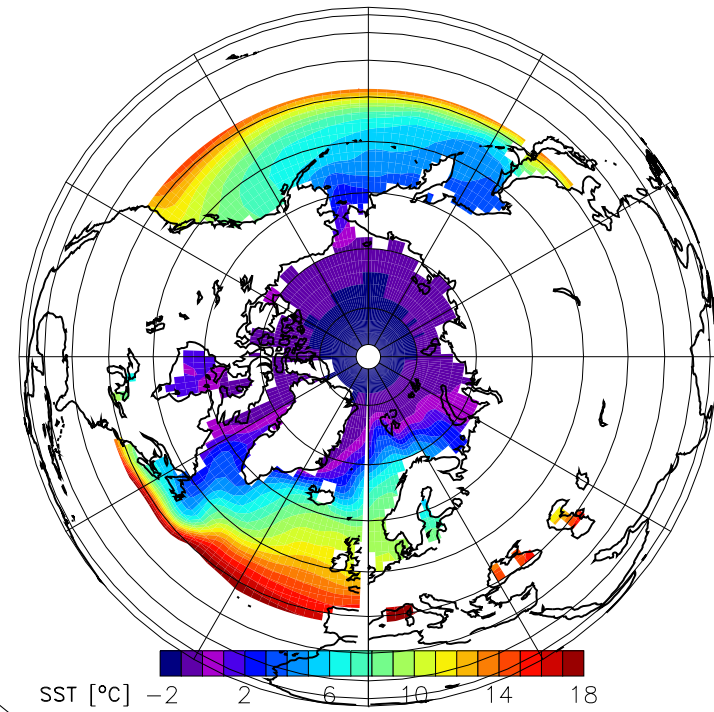
EC-Earth2.3 <1979-2012>  
- ERSSTv3b <1979-2012>



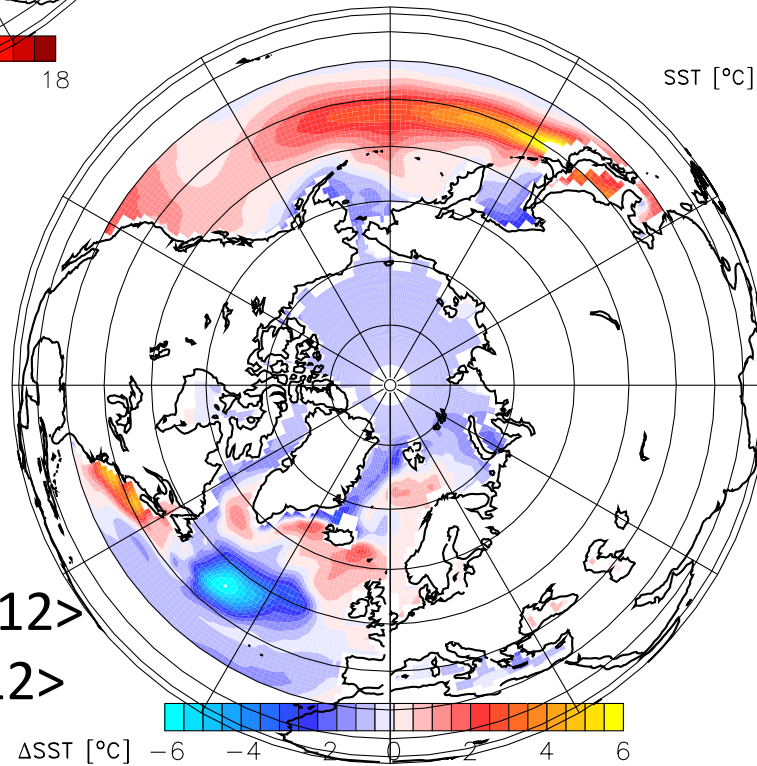
Obs. ERSSTv3b  
<1979-2012>



Hist. sim. EC-Earth2.3  
<1979-2012>



Obs. ERSSTv3b  
<1979-2012>



EC-Earth2.3 <1979-2012>  
- ERSSTv3b <1979-2012>



## ● Bias correction method I → MEAN BIAS CORRECTION

$$m_{i,l} \equiv \overline{m_l} + m'_{i,l} \text{ and } o_{i,l} \equiv \overline{o_l} + o'_{i,l},$$

$$m_{i,l} \mapsto \hat{m}_{i,l} \equiv m_{i,l} - [\overline{m_l} - \overline{o_l}] = \overline{o_l} + m'_{i,l}.$$

*m is the "raw" forecast, o is obs./reanalysis,  
i is the initial time (year), and l is the lead time*

## ● Bias correction method II → TREND BIAS CORRECTION

$$m_{i,l} \equiv [a_l^{(m)} + b_l^{(m)}i] + m''_{i,l} \text{ and } o_{i,l} \equiv [a_l^{(o)} + b_l^{(o)}i] + o''_{i,l},$$

$$m_{i,l} \mapsto \tilde{m}_{i,l} \equiv m_{i,l} - \{[a_l^{(m)} + b_l^{(m)}i] - [a_l^{(o)} + b_l^{(o)}i]\}$$

$$= \hat{m}_{i,l} - [b_l^{(m)} - b_l^{(o)}][i - \bar{i}].$$

## ● Bias correction method III → IC BIAS CORRECTION

$$m_{i,l} \equiv [\alpha_l^{(m)} + \beta_l^{(m)}o_i^{(IC)}] + m'''_{i,l} \text{ and } o_{i,l} \equiv [\alpha_l^{(o)} + \beta_l^{(o)}o_i^{(IC)}] + o'''_{i,l},$$

$$m_{i,l} \mapsto \tilde{m}_{i,l} \equiv m_{i,l} - \{[\alpha_l^{(m)} + \beta_l^{(m)}o_i^{(IC)}] - [\alpha_l^{(o)} + \beta_l^{(o)}o_i^{(IC)}]\}$$

$$= \hat{m}_{i,l} - [\beta_l^{(m)} - \beta_l^{(o)}][o_i^{(IC)} - \overline{o_i^{(IC)}}].$$

Instantaneous IC too noisy ⇒ smoothing in time  
critical for monthly and longer term predictions

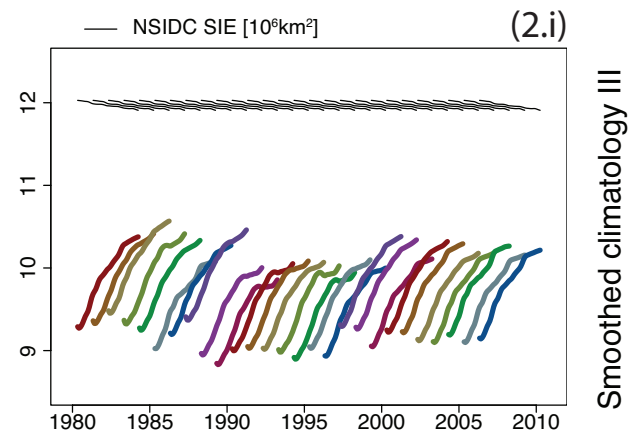
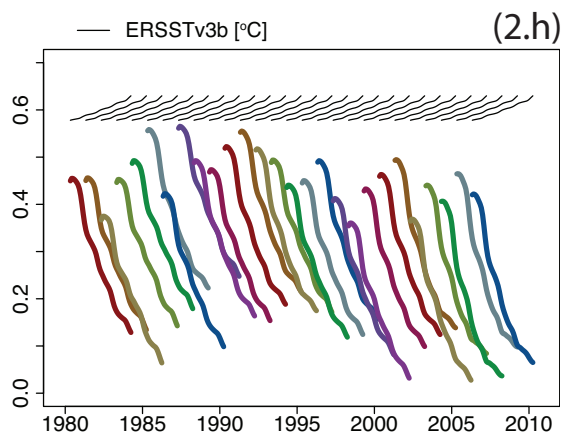
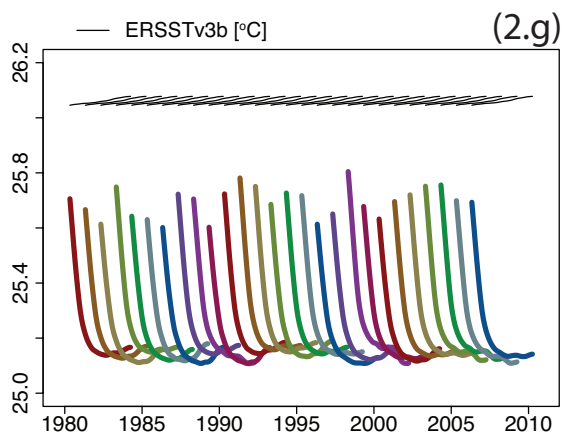
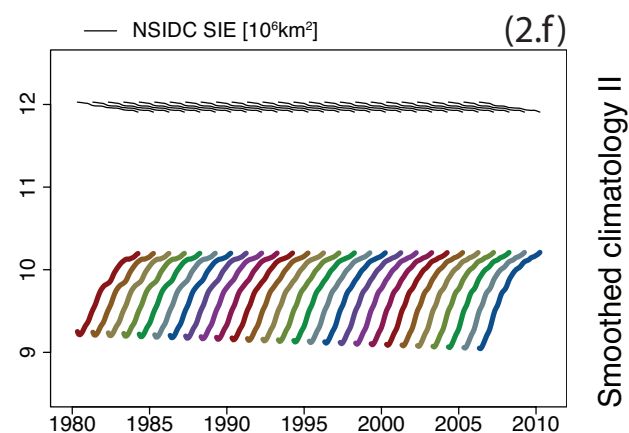
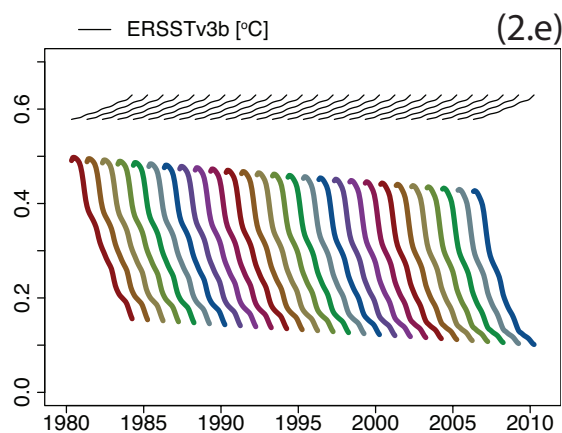
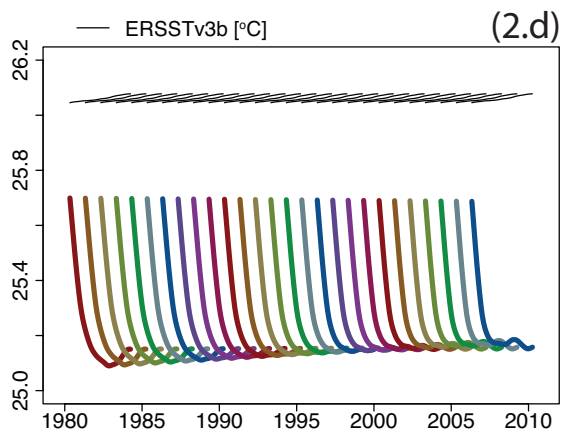
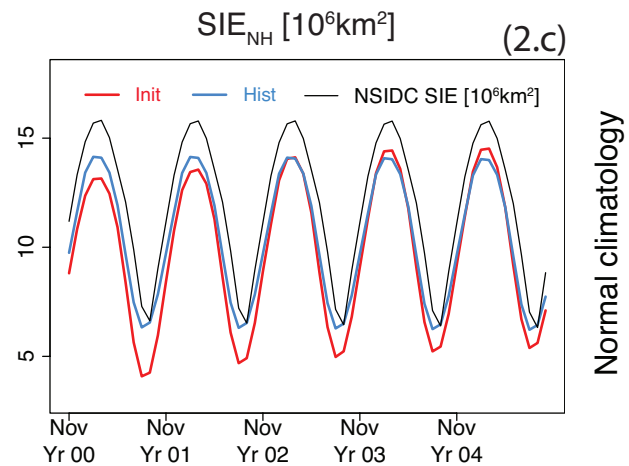
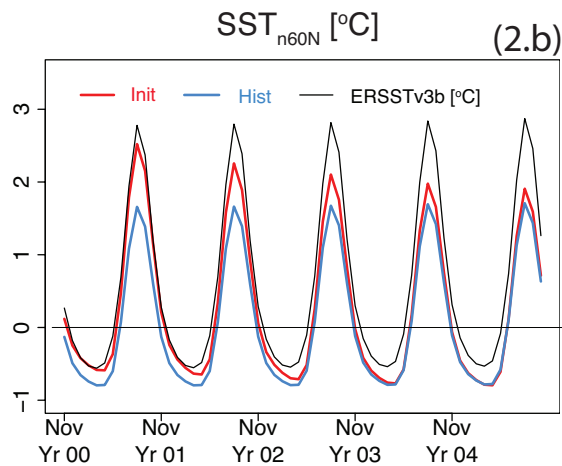
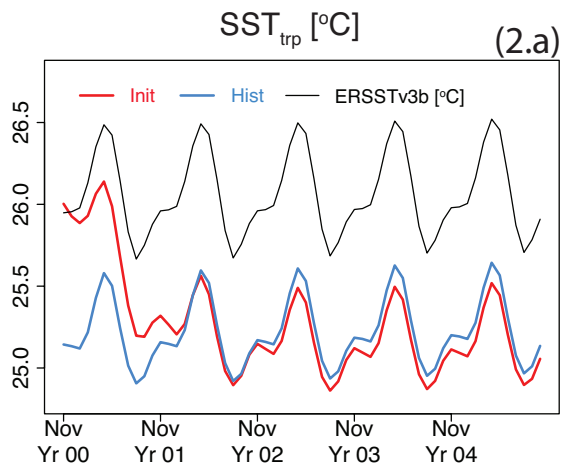
→ more versatile and more  
sensitive to obs. errors ⇒ focus  
on validation period from 1979

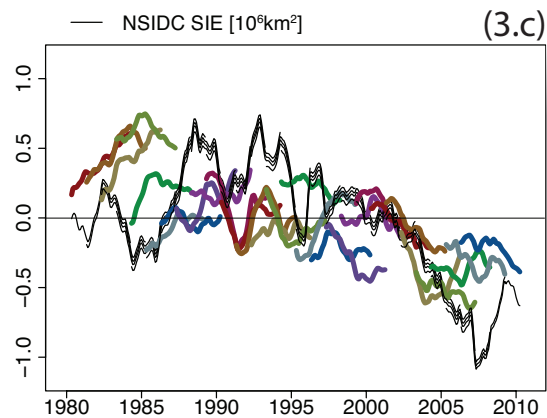
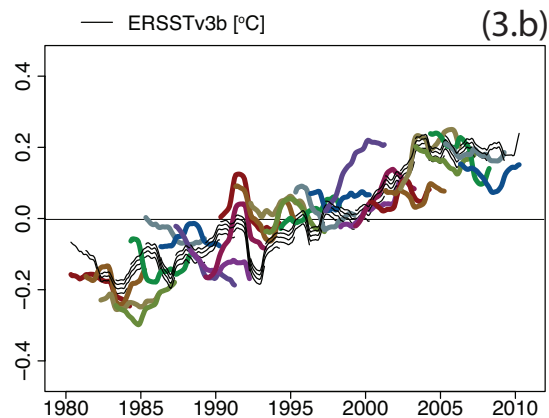
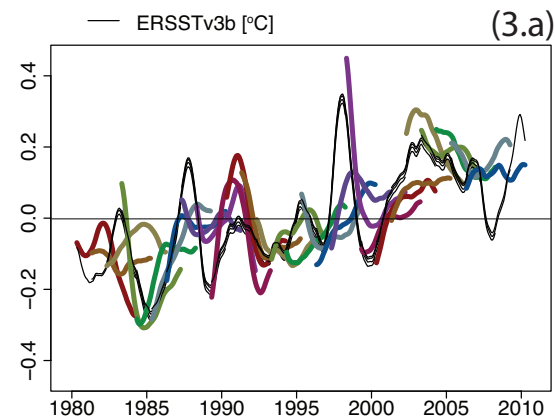
Implemented:  $o_i^{(IC)} \equiv o_{i,0}$

Other options:

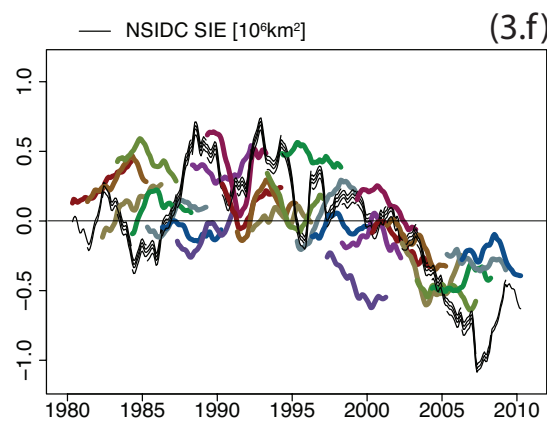
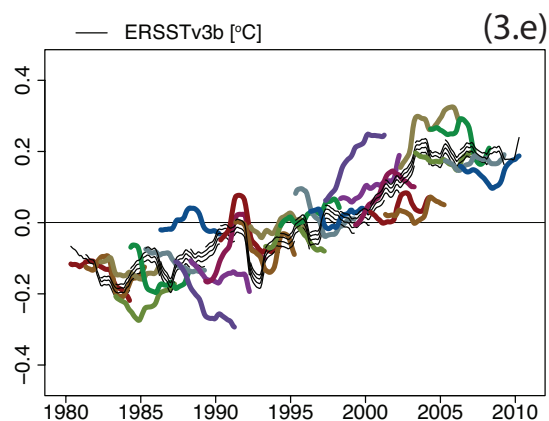
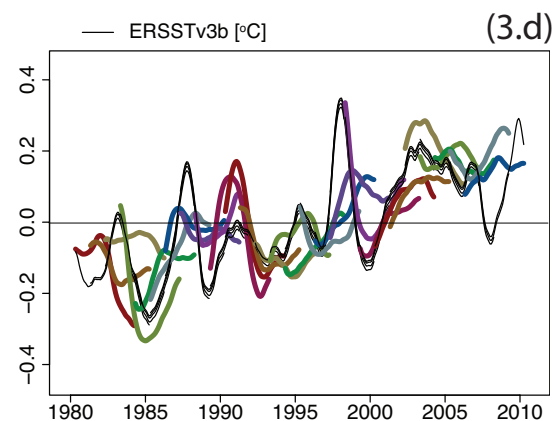
$$o_i^{(IC)} \equiv o_{i,-1}$$

$$o_i^{(IC)} \equiv (o_{i,0} + o_{i,-1})/2$$

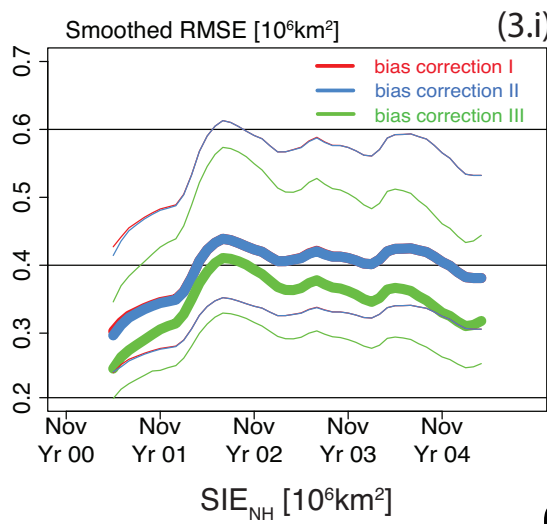
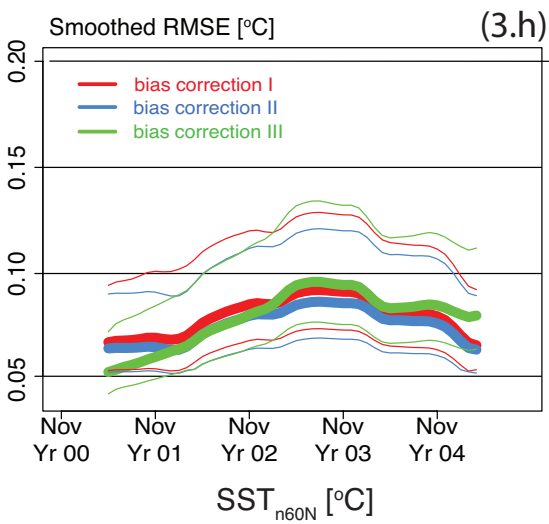
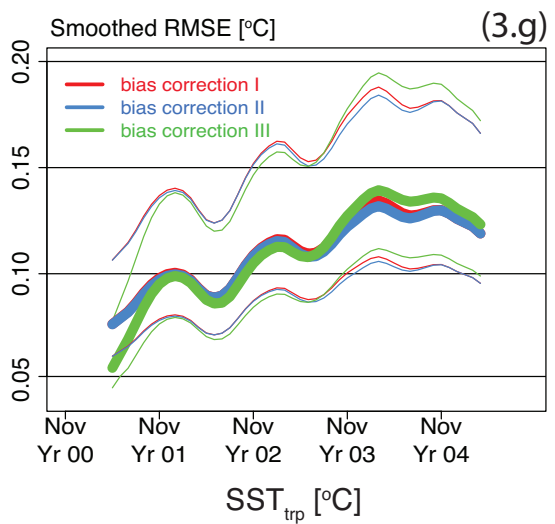




Anomalies II



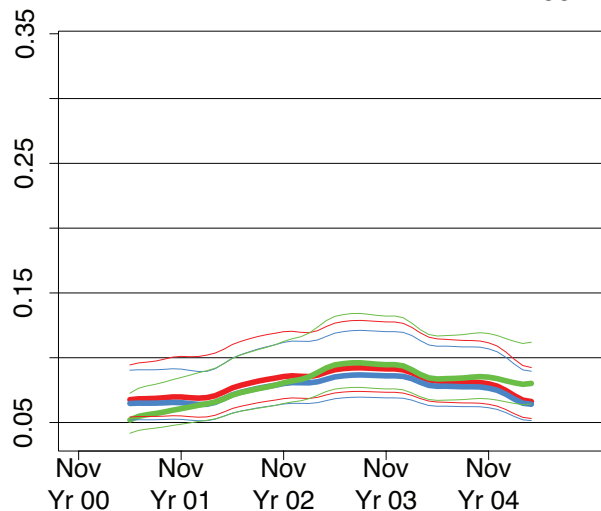
Anomalies III



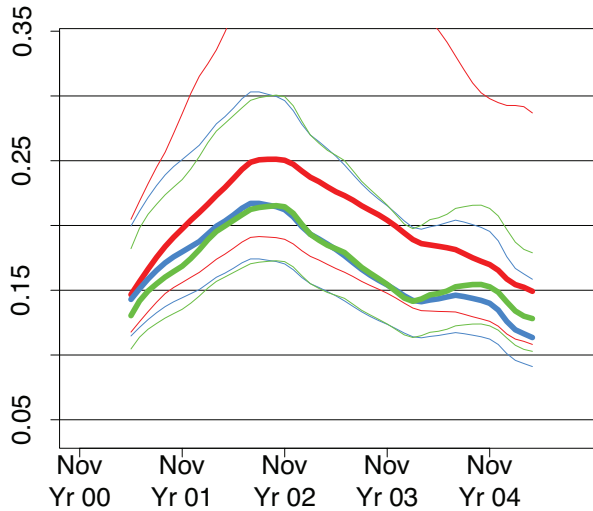
Root-mean-square error

# 12-month smoothed RMSE for SST in various regions

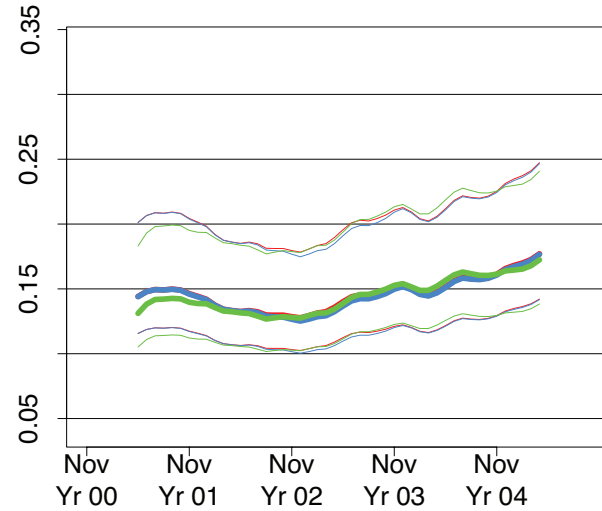
SST north of 60N = SST<sub>n60N</sub>



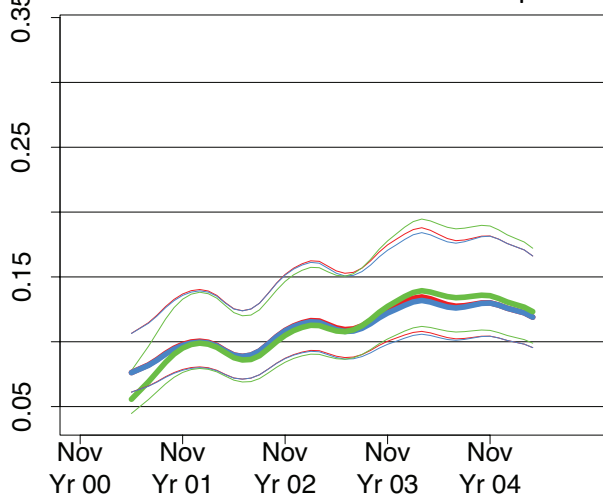
North Atlantic SST



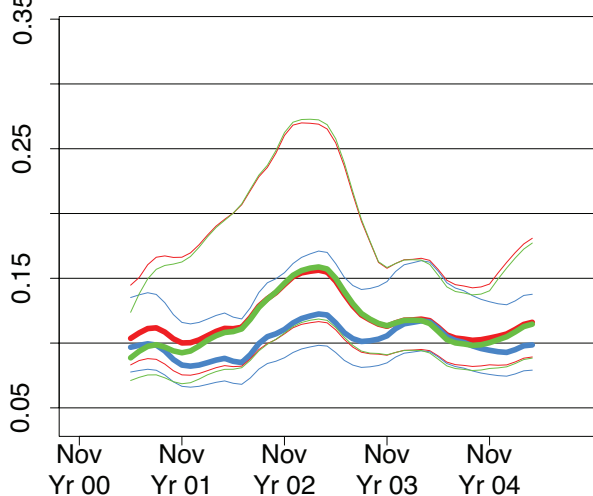
North Pacific SST



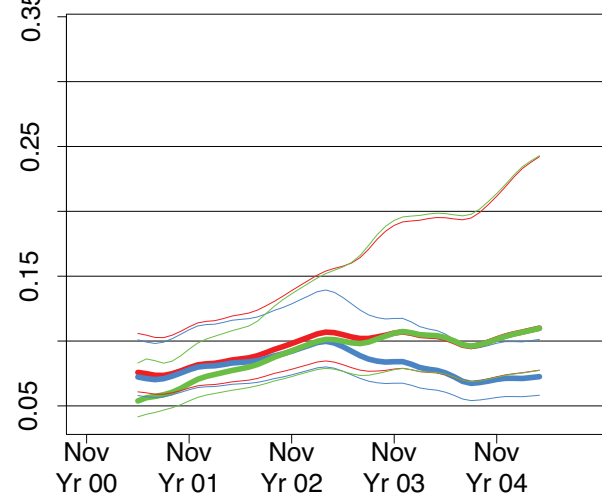
SST in tropics = SST<sub>trp</sub>



South Atlantic SST



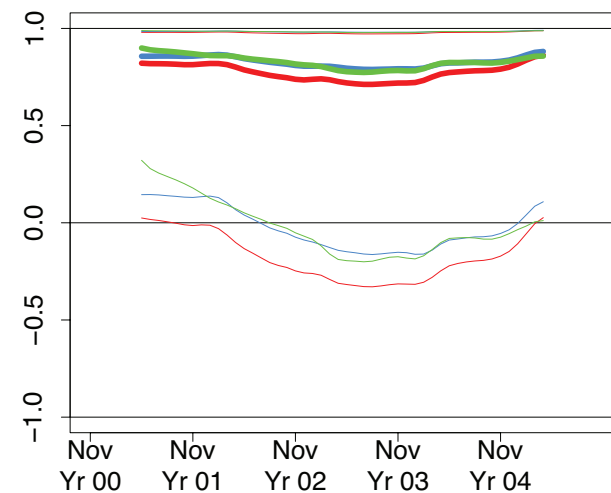
Southern Ocean SST



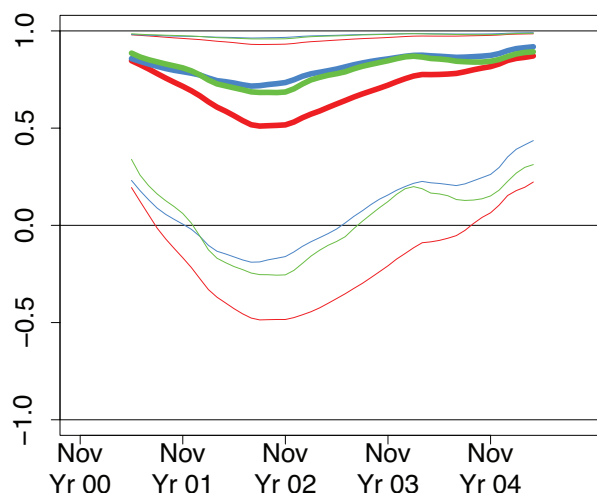


# 12-month smoothed ACC for SST in various regions

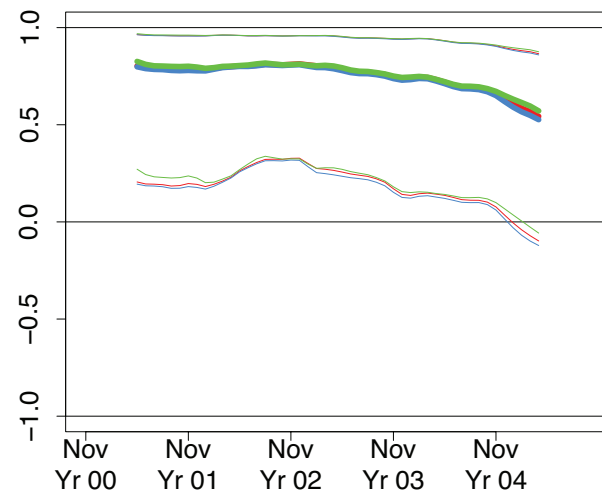
SST north of 60N = SST<sub>n60N</sub>



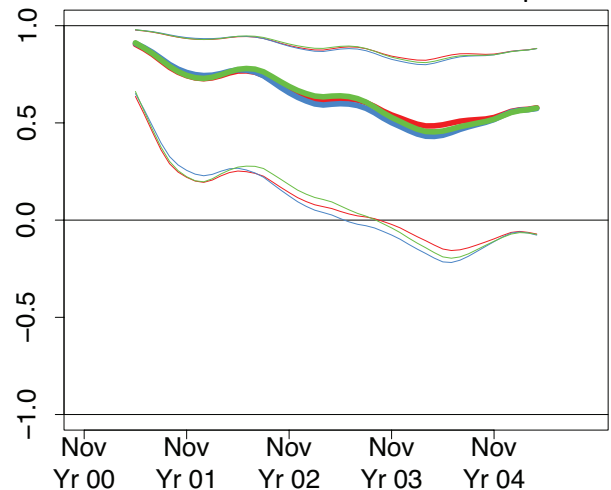
North Atlantic SST



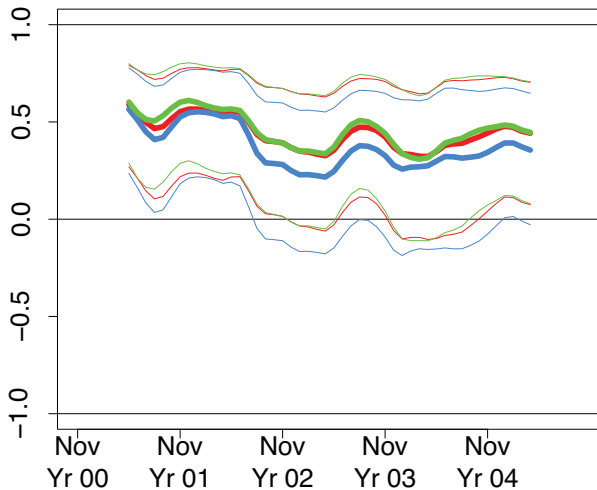
North Pacific SST



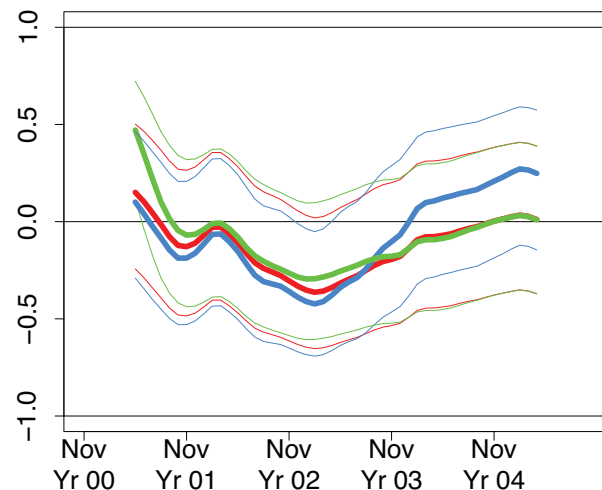
SST in tropics = SST<sub>trp</sub>



South Atlantic SST



Southern Ocean SST



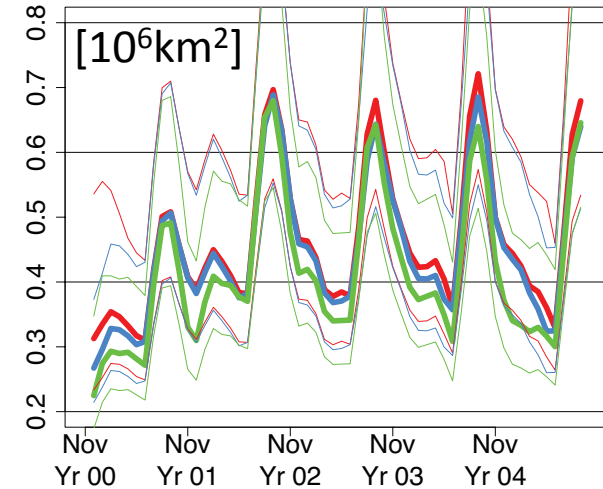
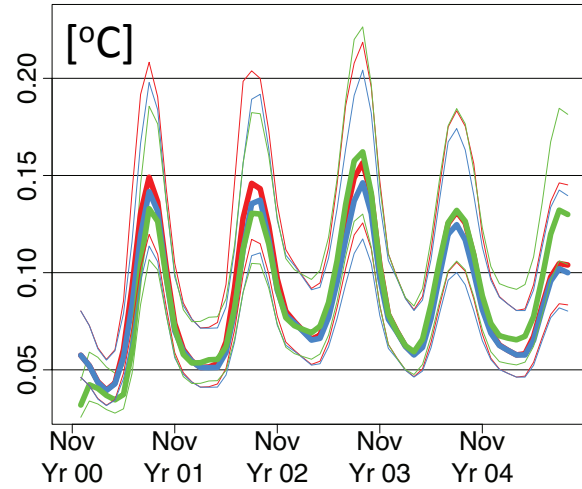
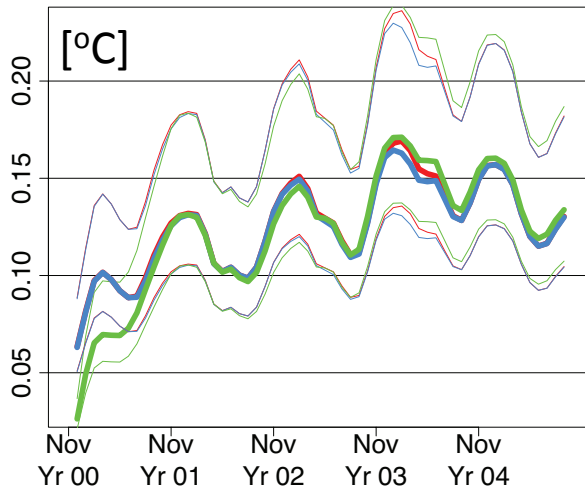
- New bias correction method  $\Rightarrow$  improvements from the 1<sup>st</sup> year up to 5 years

SST in tropics =  $SST_{\text{trp}}$

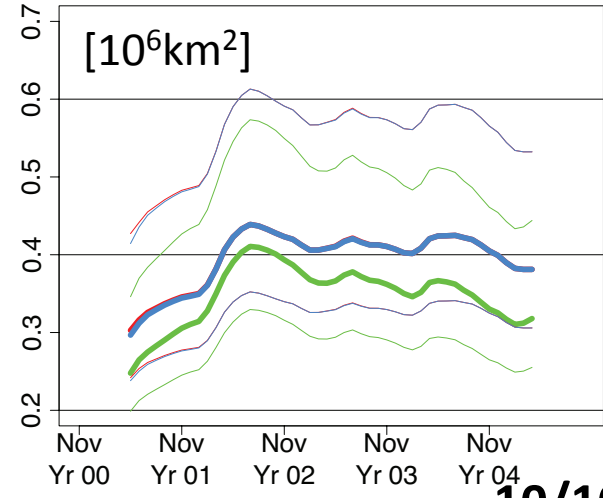
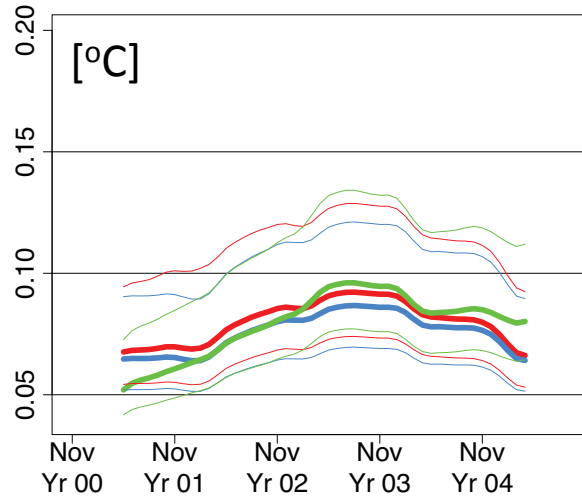
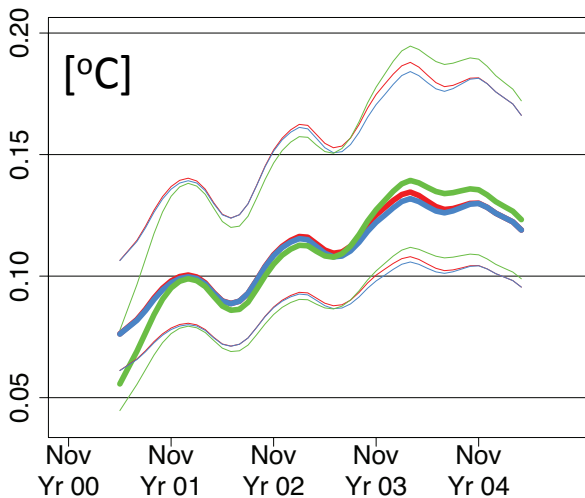
SST north of 60N =  $SST_{\text{n60N}}$

NH sea ice extent =  $SIE_{\text{NH}}$

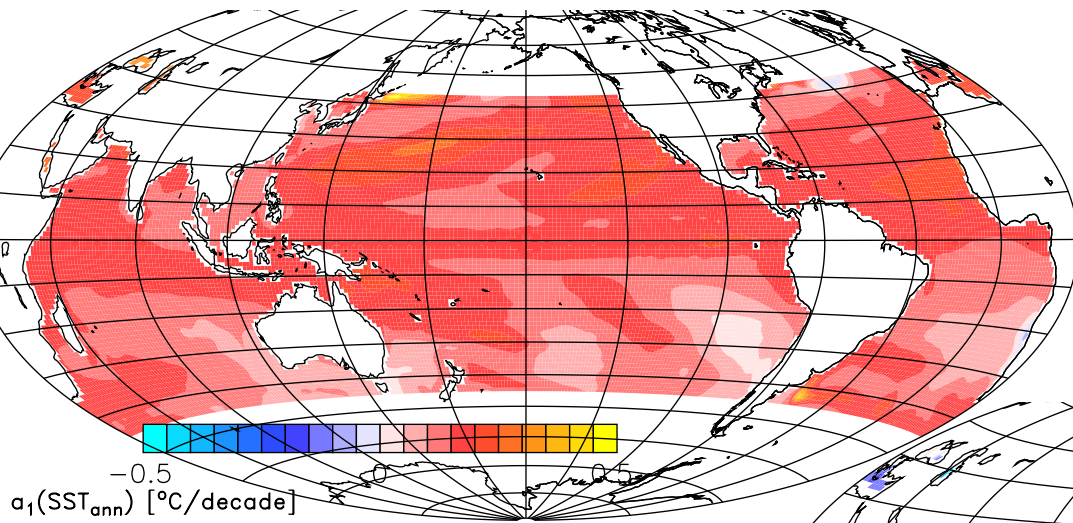
### 3-month smoothed RMSE



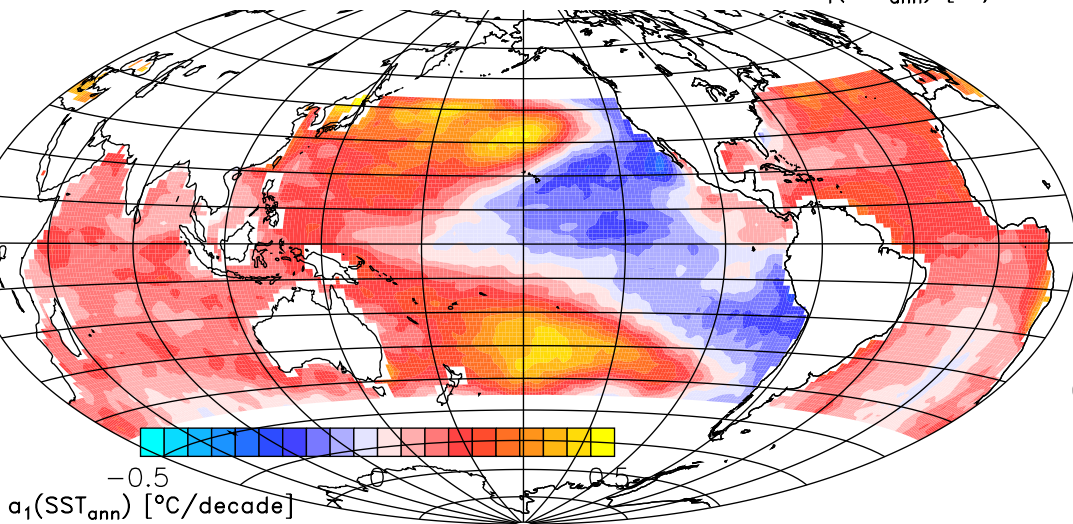
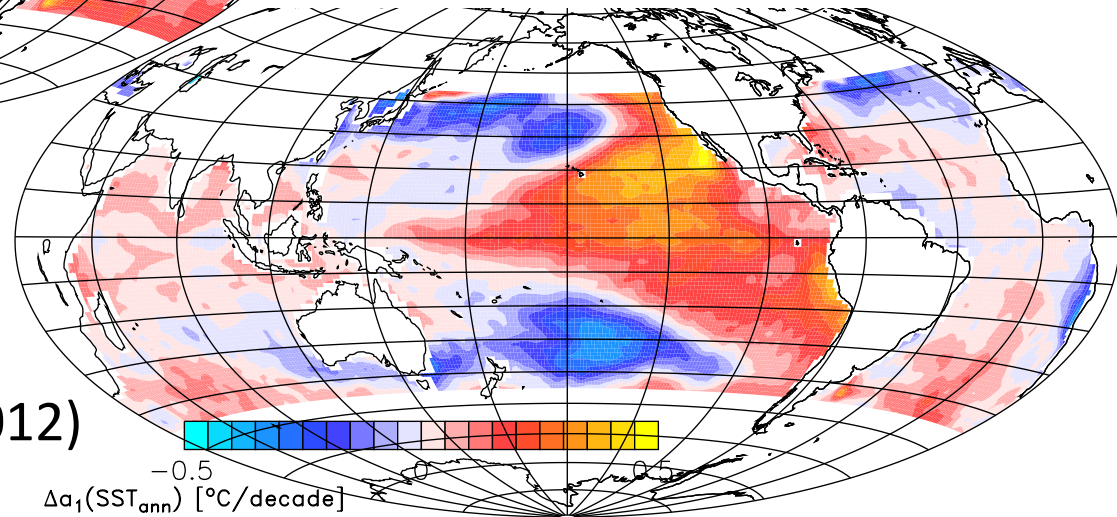
### 12-month smoothed RMSE



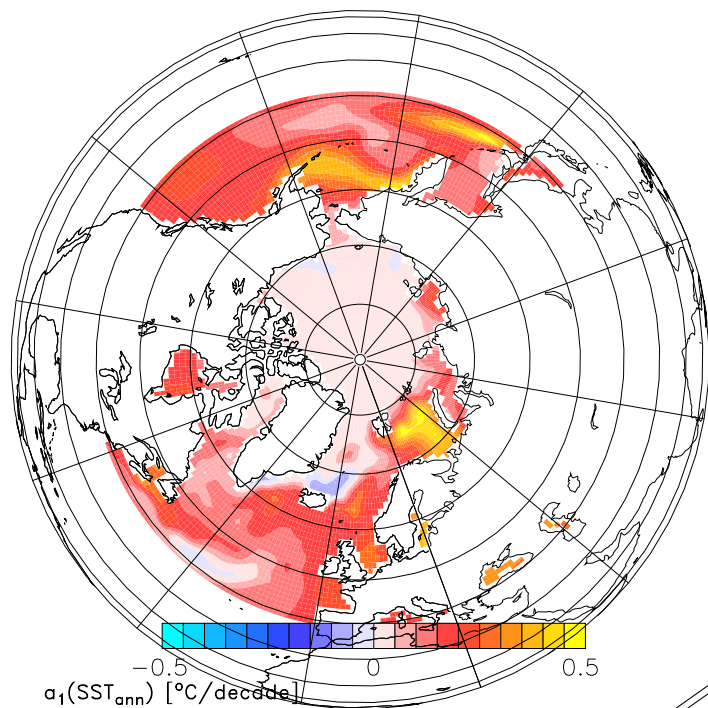
Hist. sim. EC-Earth2.3  
lin. trend (1979-2012)



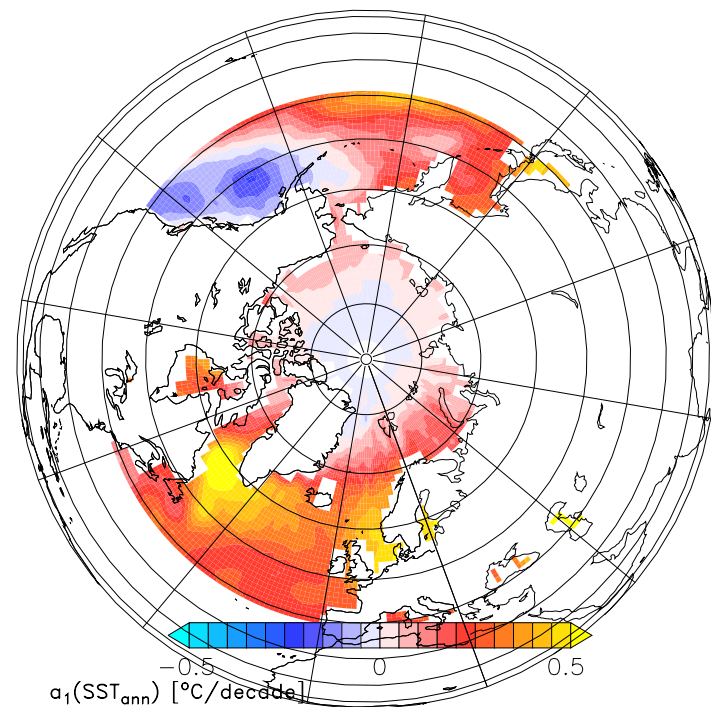
EC-Earth2.3  
lin. trend (1979-2012)  
- ERSSTv3b  
lin. trend (1979-2012)



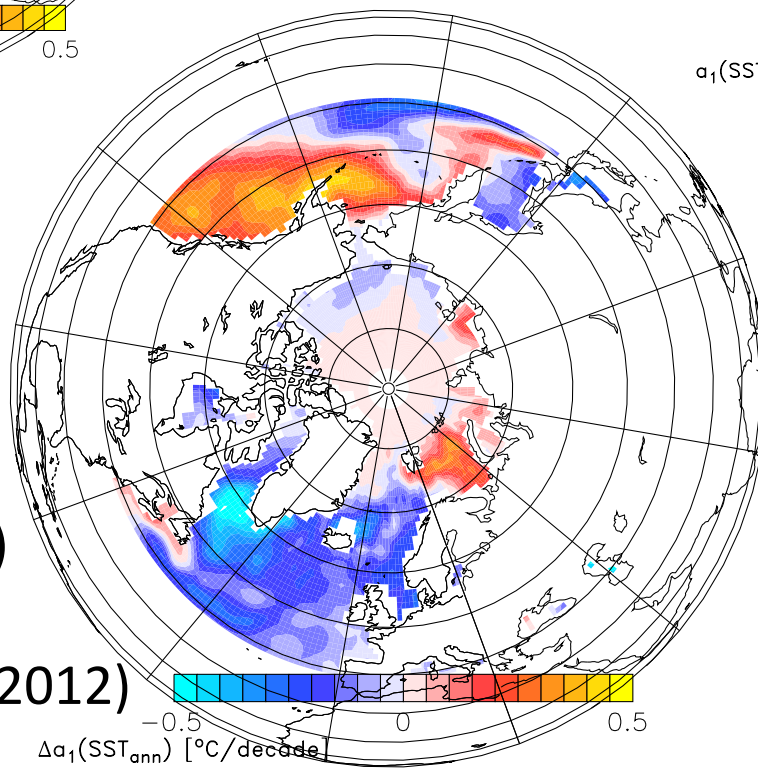
Obs. ERSSTv3b  
lin. trend (1979-2012)



Hist. sim. EC-Earth2.3  
lin. trend (1979-2012)



Obs. ERSSTv3b  
lin. trend (1979-2012)



EC-Earth2.3  
lin. trend (1979-2012)  
- ERSSTv3b  
lin. trend (1979-2012)



## Seasonal means of **tropical SST** (30°S – 30°N)

